

# A REVISION OF SEVERAL GENERA OF GYMNOSPERMOUS PLANTS FROM THE POTOMAC GROUP IN MARYLAND AND VIRGINIA.

By EDWARD W. BERRY,  
*Of the Johns Hopkins University, Baltimore.*

The present paper is the third of a series of revisions of the more important genera of fossil plants from the Potomac group in Maryland and Virginia. The first dealt with the genus *Nageiopsis* and formed No. 1738 of Volume 38<sup>1</sup> of the Proceedings. The second treated the genera *Acrostichopteris*, *Taeniopteris*, *Nilsonia*, and *Sapindopsis* and constituted No. 1769 of the same Volume 38.<sup>2</sup>

The present contribution is devoted to a consideration of the genera *Sphenolepis*, *Arthrotaxopsis*, *Cephalotaxopsis*, *Widdringtonites*, *Brachyphyllum*, *Sequoia*, *Abietites*, and *Pinus*. These are all gymnospermous genera, some of which are of disputed botanical affinity. The majority offer exceptional difficulties to their correct interpretation by reason of the convergence in foliar characters of the Mesozoic Coniferales. This is more marked than in the existing species because of the greater number of species in the Mesozoic, a period which has more than once been termed the "Era of Gymnosperms."

The genera *Arthrotaxopsis* and *Cephalotaxopsis* were originally described from the Potomac group. All of the other genera, however, are well known and for the most part widespread Mesozoic types, two, *Sequoia* and *Pinus*, surviving to the present time.

In the previous treatment of these types in the area under discussion there existed the utmost confusion and it has been necessary to check each cited occurrence by referring back to the original material in the U. S. National Museum collections. This has resulted in a most intricate splitting and combining of the named forms or parts of the named forms as they occurred in the literature, some idea of the extent and labor of which can be imagined from the following synonymy.

Forty-three species and three varieties which were formerly recognized are here replaced by 18 species. Instead of 9 species and 1 variety of *Sequoia* four are retained; 6 species and 1 variety of *Sphenolepidium*

<sup>1</sup> Pp. 185-195.

<sup>2</sup> Pp. 625-644.

are represented by 2 species of *Sphenolepis*; five species and one variety of *Glyptostrobus* disappear altogether as does also a species of *Williamsonia* and one of *Araucarites*.

While the lack of certainty pertaining to the correct recognition of coniferous foliage as ordinarily preserved in the fossil state is fully recognized it is believed that the previous segregation of these Potomac forms was entirely unwarranted and that the present conception instead of being ultra-conservative as might be deduced from the synonymy still leans in the direction of recognizing too many species. However, it approximates at least the actual status of these genera in this area during the Lower Cretaceous.

#### THE GENUS SPHENOLEPIS.

The genus *Sphenolepis* was proposed by Schenk in 1871.<sup>1</sup> In 1881 Heer proposed the generic name *Sphenolepidium* as a substitute for *Sphenolepis* on the ground that the latter had been previously used in the animal kingdom. In his treatment of these plants in Zittel's Handbuch Schenk adopts Heer's generic name which had meanwhile come into general use. As, however, all modern nomenclatorial codes both botanical and zoological do not regard the use of a name in one kingdom as prohibiting its use in the other, Schenk's original name must stand.

*Sphenolepis* may be defined as follows: Branches and twigs alternate. Phyllotaxy spiral. Leaves decurrent, more or less imbricated, acute, more or less appressed, especially on the older branches. Cones small, oblong or spherical, borne on short lateral branches. Conescales persistent, leathery, somewhat divergent at maturity, in habit suggesting *Sequoia*. The number and position of the seeds is altogether uncertain.

Although Solms-Laubach considers<sup>2</sup> that these forms can not be precisely located in any of the existing subfamilies of conifers most authors refer them to the Taxodiæ comparing them with the existing species of *Sequoia* and *Arthrotaxis*, especially the latter, with which as regards the cones, the leaf form and arrangement, and the general habit there is the closest similarity, amounting almost to an actual demonstration of relationship.

The genus appears in beds of Rhætic age both in Europe and South America. In North America one species has been recorded from the Oregon Jurassic, and Saporta has described a species from the Upper Jurassic of Portugal. Species of this genus are widespread and characteristic of the Wealden and Lower Cretaceous and constitute a very abundant element in the flora of the Potomac group, where they are represented by remains of both foliage and cones. As has been frequently pointed out, the genus may be composite.

<sup>1</sup> Schenk, Palaeontographica, vol. 19, 1871, p. 243.

<sup>2</sup> Solms-Laubach, Fossil Botany, 1891, p. 71.

SPHENOLEPIS KURRIANA (Dunker) Schenk.<sup>1</sup>

- Thuites* (*Cupressites*?) *kurrianus* DUNKER, Monogr. Norddeutsch. Weald.-bild., 1846, p. 20, pl. 7, fig. 8.
- ? *Thuites germari* DUNKER, Monogr. Norddeutsch. Weald.-bild., 1846, p. 19, pl. 9, fig. 10.
- Widdringtonites kurrianus* ENDLICHER, Synop., 1847, p. 272.—GÖPPERT, Foss. Conif., 1850, p. 176.
- Brachyphyllum kurrianum* BRONGNIART, Tableau, 1849, p. 107.
- Brachyphyllum germari* BRONGNIART, Tableau, 1849, p. 107.
- Widdringtonites haidingeri* ETTINGSHAUSEN Abhandl. k. k. geol. Reichs., vol. 1, 1851, p. 26, pl. 2, fig. 1.
- Araucarites dunkeri* ETTINGSHAUSEN (part) Abhandl. k. k. geol. Reichs., vol. 1, p. 27, pl. 2, figs. 2-10.
- Sphenolepis kurriana* SCHENK, Palaeont., vol. 19, 1871, p. 243, pl. 37, figs. 5-8; pl. 38, fig. 1 (not fig. 2, which is an *Onychiopsis*).—SCHIMPER, Pal. Végét., Atlas, 1874, pl. 110, fig. 26.—HOSIUS and v. d. MARCK, Palaeont., vol. 26, 1885, p. 216, pl. 44, fig. 209.
- Sphenolepidium kurrianum* HEER, Contrib. Flora foss. Port., 1881, p. 19, pl. 12, fig. 1b; pl. 13, figs. 1b, 8b; pl. 18, figs. 1-8.—SCHENK in Zittel, Handbuch, 1884, p. 304, fig. 210.—FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 260, pl. 126, figs. 1, 5, 6; pl. 128, figs. 1, 7; pl. 129, figs. 1, 4, 6, 8; pl. 130, fig. 11; pl. 131, fig. 4; pl. 167, fig. 2.—SAPORTA, Flora foss. Port., 1894, pp. 115, 139, pl. 22, figs. 3-5; pl. 27, fig. 15.—SEWARD, Wealden Flora, Pt. 2, 1895, p. 200, pl. 17, figs. 7, 8; pl. 18, fig. 1.—FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., pt. 2, 1899, p. 681, pl. 166, figs. 12, 13.—KERNER, Jahrb. k. k. geol. Reichs., vol. 45, Heft 1, 1896, p. 51, pl. 4, fig. 2.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 484, 489, 519, 538, 543.
- Sphenolepidium parceramosum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 257, pl. 129, fig. 7; pl. 130, fig. 8; pl. 131, fig. 2.—FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., Pt. 2, 1899, p. 682, pl. 163, fig. 11b; pl. 167, figs. 1-3.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 484, 538, 548.
- Arthrotaxopsis grandis* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 240 (part).
- Sphenolepidium virginicum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 259, pl. 125, fig. 4; pl. 166, fig. 6.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 481, 484, 517.
- Arthrotaxopsis expansa* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 241 (part), pl. 135, figs. 15, 18, 22.
- Taxodium* (*Glyptostrobus*) *expansum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 252, pl. 123, fig. 1.
- Glyptostrobus expansus* WARD, Fontaine, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 543.
- Taxodium* (*Glyptostrobus*) *denticulatum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 253, pl. 124, fig. 1.
- Taxodium* (*Glyptostrobus*) *fastigiatum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 253, pl. 125, figs. 1, 3.
- Glyptostrobus fastigiatum* WARD, 15th Ann. Rept. U. S. Geol. Surv., 1895, p. 380.
- Glyptostrobus brookensis* FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., Pt. 2, 1899, p. 682, pl. 165, fig. 4; pl. 168, fig. 4.

<sup>1</sup>The following are included in the synonymy of this species by Seward (Wealden Flora): *Muscites imbricatus* Roemer, Verstein., 1839, p. 9, pl. 17, fig. 1c (this is doubtful and would change the specific name if recognized); *Araucarites hamatus* Trautschold, Nouv. Mém. Soc. Nat. Moscou, vol. 13, 1870, p. 225, pl. 21, fig. 3; and *Thuites choffati* Heer, Contrib. Flora foss. Port., 1881, p. 11, pl. 10, fig. 8.

*Description.*—Twigs alternate, branching copiously and more or less crowded, with a tendency toward a fastigate arrangement in numerous specimens. Leaves thick, keeled dorsally, ovate in outline, often broadly so, acuminate, often slightly recurved, rather crowded and more or less appressed, but larger and much more divergent than those of the genera *Arthrotaxopsis* or the Lower Cretaceous species of *Widdringtonites*. Phyllotaxy spiral. Cones small, globose or oblate spheroidal, scales few in number, short and thick, truncate distally, becoming more or less divergent with age.

This species is very common at a large number of Lower Cretaceous horizons in both Europe and America, and it has also been recorded from the Cenomanian in Portugal, Saxony, and Austria (Lesina). It is present in the Neocomian of Portugal and Westphalia and doubtfully in beds of this age in Russia. It is present in the Wealden of England and Germany, the latter being the type area. It is also recorded from the Urgonian of Portugal and is probably present in the Kome beds of Greenland. In this country it is recorded from the Kootanic of Montana and the Fuson formation of the Black Hills. It is a very abundant form in the Potomac group, and occurs at numerous localities ranging in age from the oldest or Patuxent beds to the youngest or Patapsco beds, a range similar to but somewhat less in time than that ascribed to it in Portugal, where Saporta recognizes it from the Neocomian to the Cenomanian. Some of the numerous specimens from the Kome beds of Greenland, which Heer described first as *Widdringtonites gracilis*<sup>1</sup> and afterwards as *Cyparissidium gracile*,<sup>2</sup> are probably identical with *Sphenolepis kurriana* (Dunker) Schenk, although the cones ascribed to the former differ from those of the latter. Heer notes the resemblance between the remains of foliage of *Cyparissidium*, *Widdringtonites*, *Glyptostrobus*, *Arthrotaxis*, and *Sequoia*.

*Araucarites hamatus* Trautschold, which Seward<sup>3</sup> doubtfully includes in the synonymy, is here excluded. There is some suggestion of *Sphenolepis* in Trautschold's figures, but not enough for certainty. These figures are, however, almost identical with the coniferous twigs from Glen Rose, Texas, which Fontaine describes as *Sequoia pagiophylloides* new species.

The species may be a composite one; its wide geographical and geological range offers some basis for such a suspicion, but the materials available for study do not furnish reliable data for its segregation.

*Occurrence.*—PATUXENT FORMATION: New Reservoir, Ivy City, District of Columbia; Fredericksburg, Potomac Run, Trents Reach, Dutch Gap, Telegraph Station (Lorton), Cockpit Point, Kankeys,

<sup>1</sup> Heer, *Flora foss. Arct.*, vol. 1, 1868, p. 83, pl. 43, figs. 1e, f, g, 3c.

<sup>2</sup> Heer, *Contrib. Flora foss. Port.*, vol. 3, pt. 2, 1874, p. 74, pl. 17, fig. 5b, c; pl. 19; pl. 20, fig. 1c; pl. 21, figs. 9b, 10d.

<sup>3</sup> Wealden Flora.



Virginia. ARUNDEL FORMATION: Bay View, Arlington, Maryland. PATAPSCO FORMATION: Federal Hill (Baltimore), Vinegar Hill, Maryland; near Brooke, 72 milepost, Mount Vernon, Hell Hole, Virginia.

*Collections.*—U. S. National Museum, Johns Hopkins University.

**SPHENOLEPIS STERNBERGIANA (Dunker) Schenk.**

*Muscites sternbergianus* DUNKER, Monogr. Norddeutsch Weald.-bild., 1846, p. 20, pl. 7, fig. 10.

*Juniperites sternbergianus* BRONGNIART, Tableau, 1849, p. 108.

*Araucarites dunkeri* ETTINGSHAUSEN (part), Abhandl. k. k. geol. Reichs. vol. 1, 1851, p. 27, pl. 2, figs. 2, 3, 7, 8.

*Araucarites curvifolius* ETTINGSHAUSEN, Abhandl. k. k. geol. Reichs., vol. 1, 1851, p. 28, pl. 2, figs. 11, 13, 14, 17-21.

*Widdringtonites dunkeri* SCHIMPER, Pal. Végét., vol. 2, 1870, p. 329.

*Widdringtonites curvifolius* SCHIMPER, Pal. Végét., vol. 2, 1870, p. 329.

*Sphenolepis sternbergiana* SCHENK, Paleont. vol. 19, 1871, p. 243, pl. 37, figs. 3, 4; pl. 38, figs. 3-13.—SCHIMPER, Pal. Végét., vol. 3, 1874, p. 575, Atlas, pl. 110, fig. 27.—HOSIUS and v. d. MARCK, Paleont., vol. 26, 1885, p. 215, pl. 44, figs. 206-208.

*Sphenolepidium sternbergianum* HEER, Contrib. Flora foss. Port., 1881, p. 19, pl. 13, figs. 1a, 2-8; pl. 14.—FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 261, pl. 121, figs. 8, 10, 11; pl. 130, fig. 9.—SAPORTA, Flora foss. Port., 1894, pp. 114, 139, 193, pl. 22, figs. 1, 2; pl. 27, fig. 14; pl. 33, fig. 13.—SEWARD, Wealden Fl., pt. 2, 1895, p. 205, pl. 16, figs. 4-6.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 264, pl. 169, fig. 7.—KNOWLTON in Diller, Bull. Geol. Soc. Amer., vol. 19, 1908, p. 386.—WARD, 15th Ann. Rept. U. S. Geol. Surv., 1895, p. 359, pl. 3, fig. 1.

*Sphenolepidium sternbergianum densifolium* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 261, pl. 118, fig. 7; pl. 121, figs. 5, 7, 9; pl. 125, fig. 2; pl. 129, fig. 3; pl. 130, fig. 1; pl. 131, figs. 1, 3; pl. 132, fig. 4.—FONTAINE, Proc. U. S. Nat. Mus., vol. 16, 1893, p. 268, pl. 36, fig. 10.—FONTAINE in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 480, 481, 484, 486, 491, 507, 511, 515, 524, 528, 544, 545, 555, 573, pl. 109, figs. 8, 9; pl. 112, figs. 1, 10 (not fig. 11); pl. 115, fig. 1.

*Sequoia gracilis* HEER, Flora foss. Arct., vol. 3, pt. 2, 1873, p. 80, pl. 18, fig. 1c; pl. 22, figs. 1-10.—FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890 (not 1899), p. 247, pl. 126; figs. 3, 4.—KNOWLTON, Smiths. Misc. Coll., vol. 4, pt. 1, 1907, p. 126.—? HOLLICK, Monogr. U. S. Geol. Surv., vol. 50, 1907, p. 43, pl. 3, fig. 14.

*Description.*—Branches somewhat more remote than in *Sphenolepis kurriana*, with relatively shorter twigs. Leaves ovate, decurrent, keeled, with a broad base and acuminate apex, often divergent and falcate; in other specimens appressed. In general the leaves are much more crowded and divergent than in the preceding species. Cones not collected in connection with the American material except in the case of some poorly preserved specimens from Mount Vernon figured by Ward<sup>1</sup> which may be immature, although they suggest the preceding species rather than this one. Cones are described by Schenk from the German Wealden and are also figured by Seward from the English Wealden. The cones are small, oblate spheroidal in shape,

<sup>1</sup> Ward, 15th Ann. Rept. U. S. Geol. Surv., 1895, p. 359, pl. 3, fig. 1.

with few stout truncated scales, which become more or less divergent with maturity. Ward<sup>1</sup> reports specimens of the foliage of this species with attached staminate catkins similar to those described by Fontaine as "Male aments" from various Virginia localities, where they were not attached to recognizable twigs.

This species was described by Dunker in 1846 as a species of *Muscites*, Brongniart in 1849 substituting *Juniperites* as a more appropriate generic name, one subsequently changed to *Araucarites* by Etingshausen. Schimper referred this species to *Widdringtonites*, but since 1871 it has been rather consistently referred to as *Sphenolepsis* or *Sphenolepidium sternbergianum*, although the difficulty of dealing satisfactorily with various detached coniferous twigs of similar habit is no small one, not only from their similar appearance in various unallied species, but also because of their resistance of decay and retention of their leaves when reduced to fragments, so that they are often the most abundant remains in coarse sediments.

*Sphenolepis sternbergiana* has an equally wide range, both geographic and geologic, as has the preceding species. It is common in the Wealden of England and Germany, and is recorded by Saporta from the Neocomian, Urgonian, and Albian of Portugal, a range similar to that which it shows in the Maryland-Virginia area. It is probably represented in the Kome beds of Greenland by *Sequoia gracilis* Heer, while the latter author's *Glyptostrobus groenlandicus*<sup>2</sup> and *Sequoia fastigiata* from these beds also suggest this species. It is recorded from the Glen Rose (Trinity) beds of Texas and from the Shasta (Horsetown beds) of the Pacific coast. The form from the Upper Cretaceous of Marthas Vineyard which Hollick has identified as *Sequoia gracilis* Heer is also similar enough to be suggestive. The present species is very abundant in the Potomac Group ranging from the bottom to the top.

The specimens of *Sphenolepis sternbergiana* from the Wealden of Ecclesbourne, in possession of the writer, are much stouter than the American conifer usually identified as this species, and resemble rather closely what in America goes by the name of *Sequoia ambigua* Heer, a resemblance already commented on by Seward<sup>3</sup>. Since, however, the preservation is poor, too much importance can not be attached to a resemblance which may be purely superficial, although in the opinion of the writer it seems probable that some at least of the Wealden twigs identified as *Sphenolepis sternbergiana* may really be those of *Sequoia ambigua*, which in this country we have no difficulty in distinguishing from *Sphenolepis*.

*Occurrence.*—PATUXENT FORMATION: Fredericksburg, Telegraph Station (Lorton), Potomac Run, Alum Rock, Cockpit Point, Wood-

<sup>1</sup> 15th Ann. Rept. U. S. Geol. Surv., 1895, p. 359.

<sup>2</sup> Heer, Flora Foss. Aret., vol. 3, pt. 2, p. 76, pl. 17, fig. 9; pl. 20, figs. 9, 10.

<sup>3</sup> Wealden Flora, pt. 2, 1895, p. 206.

bridge, Virginia. ARUNDEL FORMATION: Langdon, District of Columbia; Hanover, Tip Top, Soper Hall, Maryland. PATAPSCO FORMATION: Grays Hill, Fort Foote, Stump Neck, Maryland; Mount Vernon, White House Bluff, Hell Hole, Chinkapin Hollow, 72-mile post, Dumfries Landing, near Widewater, Aquia Creek, Virginia.

*Collections.*—U. S. National Museum, Johns Hopkins University.

#### THE GENUS *ARTHROTAXOPSIS* OF FONTAINE.

The genus *Arthrotaxopsis* was named from its resemblance to the modern genus *Arthrotaxis* Don, of the subfamily Taxodiæ, which has three species confined to Tasmania.

*Arthrotaxopsis* is characterized in the following terms by its describer:<sup>1</sup>

Trees or shrubs, copiously branching, with principal stems or branches proportionally strong, cylindrical, rigid, sending off thickly placed, long, slender, cord-like, ultimate twigs, all in the same plane and spreading widely; the ultimate twigs leave the penultimate ones under a very acute angle and show a tendency to a fastigate grouping; cones mostly broadly oblong, rarely globular, obtuse and rounded at base and apex, average dimensions 10 mm. by 14 mm., attached singly on the summit of short lateral branches and placed on the lower portions of the leafy stems and branches, the twig with its cone representing the branching leafy twigs which occur higher up; scales of the cones woody, thick, wedge-shaped in the basal portions, expanded at the free ends, and probably shield-shaped, numerous, spirally placed, attached at a large angle, the middle ones being nearly or quite at a right angle with the axis, close appressed, opening with age; seed under each scale one, elliptical in shape, smooth and bony in texture, average dimensions 1 mm. by 2.5 mm.; leafy branches ending abruptly in an ultimate twig similar to those sent off pinnately and alternately lower down; leaves very thin and scale-like, elliptical, rhombic, or oblong, with varying age changing their shape, the rhombic forms representing the oldest and most crowded leaves, slightly keeled on the back, spirally arranged.

The only qualification that it is necessary to make in the foregoing description is that referring to a single, smooth, bony seed under each cone-scale. The present writer has been entirely unable to verify this feature in any of the material. The cones are of small size and comparable to the cones usually referred to *Sequoia*—i. e., with wedge-shaped, peltate scales. The material is all poorly preserved and the leafy twigs have evidently suffered greatly from decay before fossilization.

The genus may be distinguished from *Arthrotaxites* Unger,<sup>2</sup> *Echinostrobus* Schimper,<sup>3</sup> and *Cyparissidium* Heer,<sup>4</sup> all of which have very similar leafy twigs, by the characters of the cone, which are quite different. The first two are Jurassic, while the last extends from the Rhætic to the Upper Cretaceous. As a rule the twigs of *Arthrotaxopsis* are more elongated and slender than those of these other genera, indicating in all probability a pendulous habit.

<sup>1</sup> Fontaine, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 239.

<sup>2</sup> Unger, Bot. Zeit., 1849, No. 19.

<sup>3</sup> Schimper, Pal. Végét., vol. 2, 1870, p. 330.

<sup>4</sup> Heer, Flora Foss. Arct., vol. 3, pt. 2, 1874, p. 74.

As originally described *Arthrotaxopsis* contained four species. Two of these prove to be identical with the species described below, while the third was composite and included specimens of both *Sphenolepis kurriana* (Dunker) Schenk and *Sequoia ambigua* Heer.

**ARTHROTAXOPSIS GRANDIS Fontaine.**

*Arthrotaxopsis grandis* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 240 (part), pl. 114, figs. 1-3; pl. 116, figs. 1-4; pl. 135, fig. 10.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 546.

*Arthrotaxopsis tenuicaulis* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 241, pl. 114, figs. 4, 5; pl. 115, fig. 4; pl. 116, fig. 6; pl. 117, fig. 2.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 546, 520, 538, 546, 571; 19th Ann. Rept. U. S. Geol. Surv., pt. 2, 1899, p. 674, pl. 164.

*Arthrotaxopsis pachyphylla* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 242, pl. 115, figs. 1, 3; pl. 117, figs. 1, 3-5.

*Description.*—Leafy twigs elongate and slender, especially the distal ones, which are extremely attenuated and unbranched or sometimes dichotomously branched. Main branches alternate, much branched, apparently in a single plane. Distal twigs crowded, somewhat fastigate. Leaves usually thin, closely appressed, elliptical to rhombic in shape, slightly keeled, acute. Phyllotaxy spiral. Cones, small, ovoid, 5 mm. to 10 mm. in diameter and 1 cm. to 1.5 cm. in length, made up of a small number of relatively thick, wedge-shaped, peltate scales, becoming somewhat spreading with age.

This species may be distinguished from *Sphenolepis kurriana* (Dunker) Schenk, with which it was confused by Professor Fontaine by the method of branching and by its longer and more slender twigs as well as by the usually more spreading leaves of *Sphenolepis*. The material which constituted the species *tenuicaulis* and *pachyphylla* of Fontaine is not separable from that of the type. It comes from the same beds and differs merely in the condition of preservation and relative positions of the twigs upon the branch. Under *Arthrotaxopsis grandis* was also included originally certain material from near Brooke, Virginia, which is referable to *Sphenolepis*. Both the foliage and the cones are common in the Patuxent and Arundel formations, and, so far as known, they do not extend above the top of the latter. Very ambiguous material from the Hay Creek beds of the Fuson formation in Wyoming are referred to this species by Fontaine.

*Occurrence.*—PATUXENT FORMATION. Dutch Gap and Fredericksburg, Virginia; Sixteenth street, District of Columbia; Springfield, Fort Worthington,? Maryland. ARUNDEL FORMATION Tip Top (2 sp. ?), Arlington (1 sp.), Bay View (cones and foliage common), Maryland, Langdon, District of Columbia.

*Collections.*—U. S. National Museum, Johns Hopkins University.



## ARTHROTAXOPSIS EXPANSA Fontaine.

*Arthrotaxopsis expansa* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 241, pl. 113, figs. 5, 6; pl. 115, fig. 2; pl. 117, fig. 6 (not pl. 135, figs. 15, 18, 22, which are referred to *Sphenolepis kurriana* (Dunker) Schenk).—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 504, 520, 546, 571 (not pp. 533, 535, 538, 555, 573, pl. 109, figs. 12, 13, which are referred to *Sequoia ambigua* Heer, and p. 547, which is referred to *Widdringtonites ramosus* (Fontaine) Berry.

*Taxodium (Glyptostrobus) expansum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 252, pl. 123, fig. 1.

*Glyptostrobus expansus* WARD, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 543.

*Sphenolepidium sternbergianum densifolium* FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 524 (part), pl. 112, fig. 11 (not figs. 1, 10).

*Glyptostrobus brookensis* FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 483, 486, 520 (not the other citations).

*Description*.—Branches and twigs elongated and extremely slender, widely spreading and sparingly branched, showing a tendency as preserved to be in a single plane, although it can not be determined to what extent this reflects the original habit of the plant. Leaves spirally arranged, thick, keeled, acute, showing a tendency to become obtuse and less appressed, especially on the older twigs.

As here delimited this species is confined to the older Potomac, although it is very similar to those forms from the Patapsco formation, which are described as *Widdringtonites ramosus* (Fontaine) Berry, the latter being more copiously branched, less spreading, and with more acute leaves which frequently become more or less elongated. These differences may or may not be of specific value. As preserved, the two plants differ decidedly in aspect, but this is due largely to the spreading habit of the present species and is approached in some of the coniferous twigs from Mount Vernon which are referred to *Widdringtonites*.

The relation to *Arthrotaxis* implied by the name is not certain and the present species is retained in the genus to which it was referred by Professor Fontaine more from a desire to avoid changes which do not appear to be justified by the meager evidence at hand than from any conviction of relationship. For the same reason it was not transferred to *Widdringtonites*, although it seemed desirable in the case of *Widdringtonites ramosus* to make such a change and bring the latter in association with the Upper Cretaceous species of that genus, with which there is such a close agreement.

Following Seward's suggestion,<sup>1</sup> the cones which Professor Fontaine referred to this species are considered to belong to *Sphenolepis kurriana* (Dunker) Schenk, as are also some of the leafy twigs which Fontaine identified as *Arthrotaxopsis*, and a number of the recorded

<sup>1</sup> Seward, Wealden Flora, pt. 2, 1895, p. 201.



occurrences of the latter have also been found to belong to *Sequoia ambigua* Heer.

The present is another of the several species which may be compared with the foliage from the Lower Cretaceous of Greenland which Professor Heer referred to *Cyparissidium*.

*Occurrence*.—PATUXENT FORMATION: Roadside near Potomac Run, Telegraph station (Lorton), Trents Reach, Dutch Gap, Cockpit Point, Virginia; Springfield (?), Maryland. ARUNDEL FORMATION: Langdon, District of Columbia, Bay View, Tip Top (?), Maryland.

*Collections*.—U. S. National Museum.

#### THE GENUS CEPHALOTAXOPSIS OF FONTAINE.<sup>1</sup>

The utility of a new generic designation for the Potomac forms included in this genus is not altogether obvious with *Cephalotaxites* and *Taxites* already in use, but as it is in the literature and differentiates an abundant type, which is at least specifically distinct from the species usually referred to the two genera just mentioned, it is retained in the present publication. It may be characterized as follows:

*Description*.—Much branched, limbs stout, apparently in a single plane, although it is impossible to determine to what extent this is due to pressure during fossilization. Leaves flat, linear-lanceolate, coriaceous and persistent, rather variable in size, mucronate tipped; base slightly decurrent and twisted; midrib broad and flat, bordered on either side below by a stomatal groove. The leaves are distichous in habit, but the phyllotaxy was undoubtedly spiral, as it is in so many other gymnosperms with the distichous habit, and is attested by the twisted leaf bases. No fruits have been found upon any of the abundant foliage specimens, although certain associated species of *Carpolithus*<sup>2</sup> are mentioned by Professor Fontaine as the probable fruits of this genus, which are assumed to have been drupe-like with a bony seed after the manner of the existing species of *Podocarpus* and *Cephalotaxus*. This may well have been the case. The fact that no fruiting specimens occur in the abundant sterile material lends some support to this interpretation, since such fruits would stand far less chance of successful transportation by water and subsequent fossilization than would the woody buoyant cones of the majority of the conifers.

With the genus *Tumion* probably present in the Virginia Potomac and with *Nageiopsis* representing the subfamily Podocarpeæ, the family Taxaceæ is abundantly represented in the Lower Cretaceous, and when the individual abundance is considered rather than the specific differentiation, it must be admitted that this family furnishes an important element in the Potomac flora.

<sup>1</sup> Fontaine, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 235.

<sup>2</sup> *C. fasciculatus*, *C. mucronatus*, *C. sessilis*, *C. ternatus*.

Heer<sup>1</sup> has described a leafy twig from the Patoot beds of Greenland (Senonian) bearing a large solitary drupe-like fruit which he calls *Cephalotaxites insignis*, an identification which Solms-Laubach<sup>2</sup> seems to consider probable. Bertrand<sup>3</sup> has described structural material of fruits allied to *Cephalotaxus* under the name of *Vesquia tournaisii* from the Aachenian of Belgium, and the present writer has described<sup>4</sup> similar fruits which are common in the Upper Cretaceous of the southern Atlantic Coastal Plain.

The existing genus *Cephalotaxus* Siebold and Zuccarini, contains four species confined to the Chinese-Japanese region. It was evidently much more widespread in former geologic times, and to it should possibly be referred some of the leafy twigs included in the genus *Taxites* Brongniart. Fruit of three species of *Cephalotaxus*, apparently identified correctly, are described by Kinkelin<sup>5</sup> from the Pliocene deposits of Germany.

CEPHALOTAXOPSIS MAGNIFOLIA Fontaine.

*Cephalotaxopsis magnifolia* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 236, pl. 104, figs. 4, 5; pl. 105, figs. 1, 2, 4; pl. 106, figs. 1, 3; pl. 107, figs. 1, 2, 4; pl. 108, figs. 1, 3, 4.—FONTAINE, in Diller and Stanton, Bull. Geol. Soc. Amer., vol. 5, 1894, p. 450.—FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., Pt. 2, 1899, p. 686, pl. 162, fig. 1b; pl. 169, figs. 3, 4.

*Cephalotaxopsis ramosa* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 237, pl. 104, figs. 2, 3; pl. 106, figs. 2, 4; pl. 107, fig. 3; pl. 108, fig. 2.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 258(?), pl. 68, figs. 5-7(?) (not p. 311, pl. 73, fig. 8, which is referred to *Oleandra*, or p. 547, which is referred to *Nageiopsis angustifolia*).

(?) *Cephalotaxopsis* ? *rhytidodes* WARD, Fontaine, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 258, pl. 68, fig. 8.

(?) *Cephalotaxopsis*, *species* FONTAINE, in Diller and Stanton, Bull. Geol. Soc. Amer., vol. 5, 1894, p. 450.

*Description.*—Branches very stout, more or less branched, in some instances apparently in whorls through the suppression of the terminal bud and the development of lateral shoots. Leaves distichous in habit, but probably with a spiral phyllotaxis, strikingly similar to those of the modern species of *Cephalotaxus*, linear-lanceolate in outline, rather abruptly rounded at the base and tapering gradually upward. Apex with a mucronate point. Length 2 cm. to 6 cm., averaging 4 cm. or 5 cm. and becoming regularly smaller distally and also smaller at the base of the new shoots. Width 3 mm. to 4 mm. Texture coriaceous. The midrib is broad and flat, occupying about one-seventeenth of the diameter of the leaf. The epidermal cells are arranged in rows; they are small in size and thick-walled, quadrangular or slightly hexagonal in outline, ranging from proportions but

<sup>1</sup> Heer, Flora Foss. Arct., vol. 7, 1883, p. 10, pl. 53, fig. 12.

<sup>2</sup> Solms-Laubach, Fossil Botany, 1891, p. 61.

<sup>3</sup> Bertrand Bull. soc. bot. France, vol. 30, 1883, p. 293.

<sup>4</sup> Berry, Bull. Torrey Club, vol. 37, 1910, p. 187.

<sup>5</sup> Engelhardt and Kinkelin, Abh. Senckenb. Naturf. Gesell. vol. 39, Heft 3, 1908, p. 194, pl. 23, figs. 9, 13.

slightly longer than wide to those in which the length is about three times the width. On the lower surface of the leaf on either side of the midrib, commencing one-fifth of the distance to the margin and occupying a width of one-fourth the distance to the margin, are the stomatal grooves. They are deeply sunken and appear to have been floored with thin-walled cells not well preserved. There is some evidence of the occurrence of a woolly scurf in these grooves, but the preservation is such that this can not be positively asserted. The stomata were comparatively large and irregularly scattered in the floor of the groove. They are without definite arrangement or orientation. The guard cells are two in number, long, much curved, and slender.

This species is exceedingly common in the Patuxent formation of Virginia, to which it appears to be confined in the Atlantic coastal plain province. Although it has not yet been reported from the Kootanie formation of the Montana area, it is present in both the Lakota and Fuson formations of the Black Hills Rim and in the Shasta beds of California. At no localities, however, is it as abundant as in the lowest Potomac of Virginia. It is strikingly like the modern *Cephalotaxus* in appearance and may also be compared with various fossil species of *Taxites*.

*Occurrence*.—PATUXENT FORMATION: Fredericksburg, near Dutch Gap, and near Potomac Run, Virginia.

*Collections*.—U. S. National Museum.

#### CEPHALOTAXOPSIS BREVIFOLIA Fontaine.

*Cephalotaxopsis brevifolia* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, p. 238, pl. 105, fig. 3; pl. 106, fig. 5; pl. 107, fig. 5.

*Cephalotaxopsis microphylla* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 238, pl. 108, fig. 5; pl. 109, fig. 9.

*Description*.—Ultimate branches alternate and rather slender. Leaves distichous in habit, narrowly lanceolate, 7 mm. to 21 mm. in length, averaging 10 mm. to 12 mm. Width 1 mm. to 3 mm., averaging about 2 mm. Apex and base almost equally acute, the base slightly less so. Texture coriaceous. Fontaine says of this species: "Midnerve slender." It is, on the contrary, extremely broad, but flat and not prominent. In the specimen which is Fontaine's, plate 106, figure 5, the midrib occupies one-fifth of the maximum width of the leaf. This specimen exposes the upper surfaces of the leaves, in consequence of which the midrib and stomatal bands are obscured.

This species, which may simply represent certain terminal or abortive shoots of the preceding, is not at all common and is confined to the Patuxent formation of Virginia. It may be profitably compared with some of the Mesozoic species of *Taxites*.

*Occurrence*.—PATUXENT FORMATION: Fredericksburg, near Dutch Gap, and near Potomac Run, Virginia.

*Collections*.—U. S. National Museum.

## THE GENUS WIDDRINGTONITES.

The genus *Widdringtonites* was established by Endlicher in 1847<sup>1</sup> with *Thuites gramineus* Sternberg<sup>2</sup> from the Tertiary of Perutz, Bohemia as the type. This he named *Widdringtonites ungeri*, including in its synonymy *Juniperites baccifera* Unger, *Thuia graminea* Brongniart, and *Muscites stolzii* Sternberg. Three additional species were listed, one from the Cretaceous, one from the Wealden, and one from the Lias. His characterization of the genus was as follows: "Folia spiraliter inserta, pleraque squamæformia adpressa. Strobilus globosus, valvatus."

There are perhaps a score of species ranging in age from the Triassic to the Miocene referred to this genus at the present time. It has been commonly used for foliar specimens which resembled the living forms, but which lacked the certainty furnished by associated cones. These are known, however, in a large number of species, many of which, especially those of Tertiary age, being now referred to the still existing genus *Widdringtonia*.

Although fruiting specimens of *Widdringtonites ramosus* are unknown, its immediate successor *Widdringtonites reichii* (Ettingshausen) Heer of the Raritan and Magothy formations has, in the European material, furnished abundant four-valved cones which induce Velenovsky and Krasser to advocate its reference to *Widdringtonia*. *Widdringtonites subtilis* Heer, which is common in the later Cretaceous of the Atlantic Coastal Plain, has also furnished somewhat poorly preserved cones of this generic type in material collected by the writer in South Carolina and well preserved attached cones in material from the Tuscaloosa formation in Alabama.

There can be but little doubt of the actual genetic relationship between a number of these Mesozoic conifers and the existing species of *Callitris*, *Widdringtonia*, and *Frenela*, which Eichler lumps into the single genus *Callitris* Vent. At the present time they constitute a restricted group confined to the Australian region on the one hand (*Frenela*) and to northern Africa (*Eucallitris*) and southern Africa and Madagascar (*Widdringtonia*) on the other. In former geological periods they were much more abundant. *Frenelopsis* is recorded in America from Greenland to Texas and *Widdringtonites* from Greenland to South Carolina. Abroad both types occur abundantly in central and western Europe. Like so many other types of plants which were widespread in Mesozoic times they became during the Tertiary more and more restricted in their range until today they are not found at all in the Western Hemisphere.

<sup>1</sup> Endlicher, Synop. Conif., 1847, p. 271.

<sup>2</sup> Sternberg, Flora Vorwelt, Tentamen, 1825, p. 38, pl. 35, fig. 4.



Referring only to Cretaceous species of *Widdringtonites* we find four in the Neocomian, one in the Urgonian, one in the Albian, three in the Cenomanian, and one in the Senonian.

WIDDRINGTONITES RAMOSUS (Fontaine).

*Taxodium (Glyptostrobus) ramosum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 251, pl. 123, figs. 2, 3; pl. 124, fig. 2; pl. 127, fig. 1; pl. 166, fig. 1.

*Glyptostrobus ramosum* WARD, Fontaine, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 281 (?), 489, 544.

*Taxodium (Glyptostrobus) brookense* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 254, pl. 122, fig. 1; pl. 124, figs. 3-9; pl. 131, fig. 5; pl. 165, figs. 1-3; pl. 166, figs. 4, 7; pl. 167, fig. 3.

*Glyptostrobus brookensis* WARD, 15th Ann. Rept. U. S. Geol. Surv., 1895, p. 359.—FONTAINE in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 481, 483, 486, 489, 495, pl. 110, fig. 1 (not pp. 483, 486, 520, which are referred to *Arthrotaxopsis expansa* Fontaine).

*Taxodium (Glyptostrobus) brookense angustifolium* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 256, pl. 167, fig. 1.

*Glyptostrobus brookensis angustifolium* KNOWLTON, Bull. U. S. Geol. Surv., vol. 152, 1898, p. 112.—FONTAINE in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 489, pl. 108, fig. 4.

*Arthrotaxopsis expansa* FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 547 (not balance of the original citation).

*Description.*—Fontaine's original description in 1890 was as follows:

The principal stems seen are moderately stout and very rigid, the secondary ones mostly slender and rigid, the ultimate ones usually very long, slender, and unbranched, wide-spreading, often very delicate and thread-like, going off at an angle of about 45°, but from distortion due to pressure frequently appearing fastigate and irregularly grouped; leaves on the oldest stems elongate-linear, acute, close appressed, on the younger stems all very narrowly oblong, or narrowly elliptical, acute to obtuse, very closely appressed, not distinctly visible without help of a lens in many cases, all spirally arranged; the facial leaves usually acute, the lateral ones usually more obtuse and sometimes slightly divergent at the tips and incurved; midnerves slender and thread-like.

Since nowhere in the Potomac group are cones or scales found which indicate the presence of *Glyptostrobus*, it seems desirable to refer these species and variety of Professor Fontaine's to the genus *Widdringtonites* because of their extremely close resemblance to *Widdringtonites reichii* (Ettingshausen) Heer which is so widespread and characteristic a form in the Cenomanian of both the Old and New World. In fact it may be eventually desirable to reduce this Patapsco species to the synonymy of the latter, to which it is at least very closely allied. The variety *angustifolium* Fontaine is not distinguishable from the type and is based on specimens slightly more slender than the average, but readily matched in the material which that author refers to the type-species. *Glyptostrobus ramosum* (Fontaine) Ward is clearly identical with the other forms which are included by Fontaine in this species and comes from the same outcrops with the exception of certain material from the Kootanie at



Great Falls, Montana, which Professor Fontaine has identified as *Glyptostrobus ramosum*, but which is in all probability *Glyptostrobus groenlandicus* Heer and not identical with the Potomac species, although detached twigs of the two may and do show considerable similarity.

The material from the Fuson formation of eastern Wyoming which Fontaine referred to his *Glyptostrobus brookensis*, a synonym of *Widdringtonites ramosus*, is clearly identical with *Sphenolepis kurriana* (Dunker) Schenk, which occurs in the same beds with it, and quite different from the species under discussion.

*Widdringtonites ramosus* is a characteristic species of the Patapsco formation both in Maryland and Virginia and occurs in considerable abundance at numerous localities. It is undoubtedly the ancestor of *Widdringtonites reichii* (Ettingshausen) Heer of the Raritan and Magothy formations.

*Occurrence.*—PATAPSCO FORMATION: Vinegar Hill, Fort Foote Overlook Inn Road, Stump Neck, near Wellhams, Maryland; Mount Vernon, Hell Hole, White House Bluff, near Brooke, 72 milepost, Virginia.

*Collections.*—U. S. National Museum.

#### THE GENUS BRACHYPHYLLUM.

The genus *Brachyphyllum* was proposed by Brongniart in 1828<sup>1</sup> for conifers with short, fleshy, spirally arranged leaves attached by their broad rhomboidal bases. The type-species, *Brachyphyllum mamillare* from the Lower Oolite, was described, but not figured, and was placed under the heading *conifère doutense*. In 1849 the same author<sup>2</sup> compared this genus with the existing genera *Arthrotaxis*, *Widdringtonia*, and *Glyptostrobus*. Schimper<sup>3</sup> in 1872 somewhat restricted the genus and also extended Brongniart's diagnosis. Saporta<sup>4</sup> also gives a rather well-illustrated account of *Brachyphyllum* figuring Brongniart's type and pointing out its doubtful botanical affinity. Seward<sup>5</sup> regards *Brachyphyllum* as a purely provisional genus, the actual botanical position of which is very uncertain, and further states that it is quite probable that more than one family of conifers are included under this name. Comparisons have been made at various times with the modern subfamilies Araucariæ, Taxodiæ, and Cupressæ, especially with the Tasmanian genus *Arthrotaxus* of Don and the Araucarian species *Araucaria imbricata*.

*Brachyphyllum* may be defined as a genus of arborescent conifers the twigs of which are thick and club-shaped, irregularly distichous

<sup>1</sup> Brongniart, Prodrôme, 1828, p. 109.

<sup>2</sup> Brongniart, Tableau, 1849, p. 69.

<sup>3</sup> Schimper, Traité, vol. 2, 1872, p. 334.

<sup>4</sup> Saporta, Pal. franc., 1883, vol. 3, p. 310.

<sup>5</sup> Seward, Cat. Wealden Flora, pt. 2, 1895, p. 214.

in their mode of branching. The leaves are squamate, very short, thick, appressed, and densely crowded. Phyllotaxis spiral. In life the leaves must have been more or less fleshy, mutual pressure causing them to assume a pentagonal or hexagonal outline, with a dorsal, slightly projecting carina or boss becoming more or less obliterated with age. Leaf surface more or less striated, the striæ converging to the obtuse apical point (at least this is true of our American Cretaceous species). The leaf-scars on old branches are said to be rhomboidal and continuous, remotely suggestive of *Lepidodendron*.

A variety of cones have been referred to this genus usually upon the unreliable evidence of association in the same stratum. Even when cones are found in actual connection with the leafy twigs their preservation is such that positive evidence of botanical relationship is not available. Newberry describes<sup>1</sup> a large cylindrical cone with a length of 20 centimeters and a diameter of 4 centimeters and having spatulate scales, which he is quite positive is the cone of the *Brachyphyllum* so common in the upper part of the Raritan clays of New Jersey. As against these cones described by Newberry most cones referred to *Brachyphyllum* have been small and somewhat spheroidal in shape. Thus Zeiller described branches of *Brachyphyllum* from the Lias of Madagascar which bore small ovoid cones with rhomboidal scales very suggestive of *Sequoia* and he seems to think it probable that some of the forms of *Brachyphyllum* are referable to the Taxodiæ while others have an affinity with the Araucariæ. Saporta<sup>2</sup> figures elliptical Walchia-like cones which he found associated with *Brachyphyllum jauberti*, *gracile*, and *moreauanum* in the French Jurassic while Heer describes<sup>3</sup> and figures spherical cones with polygonal scales attached to twigs of his *Brachyphyllum insigne* from the Lower Oolite of Siberia, and other records of a very similar nature might be mentioned. Fontaine has recorded three obscure varieties of small cones from the Patuxent beds along the James River in Virginia which he refers to *Brachyphyllum*.<sup>4</sup> They are very indefinite and poorly preserved but may be correctly identified. Finally Hollick and Jeffrey have rendered it extremely probable<sup>5</sup> that the widespread coniferous scales of the mid-Cretaceous referred to *Dammara* are related to *Brachyphyllum* and these authors have proved, at least in the species formerly known as *Dammara microlepis* Heer from Staten Island, a relation to twigs of the *Brachyphyllum* type, which relationship would seem to effectually disprove the identity of the cones described by Newberry.

<sup>1</sup> Newberry, *Flora Amboy Clays*, 1896, p. 51, pl. 7, figs. 3, 4, 6.

<sup>2</sup> Saporta, *Plantes Jurassiques*, vol. 3, 1884, pp. 341, 349, 365, pl. 165, figs. 1, 2; pl. 167, fig. 2; pl. 171; figs. 5-9.

<sup>3</sup> Heer, *Flora Foss. Arct.*, vol. 4, pt. 2, 1876, p. 75, pl. 13, fig. 9.

<sup>4</sup> Fontaine, *Monogr. U. S. Geol. Surv.*, vol. 15, 1890, pp. 223, 224, pl. 135, figs. 8, 9; pl. 168, fig. 2.

<sup>5</sup> Hollick and Jeffrey, *Amer. Nat.*, vol. 40, 1906, p. 200.

Leafy branches and twigs very similar in appearance to those of *Brachyphyllum* in which, however, the leaves are less thick and more free and pointed are often referred to the genus *Echinostrobus* which was founded by Schimper in 1872 for four or five Jurassic species of conifers, and it is to this Jurassic genus that Velenovsky refers two species from the Cenomanian of Bohemia,<sup>1</sup> although these latter are both practically identical with *Brachyphyllum macrocarpum* Newberry from the nearly homotaxial American horizons.

The geological range of *Brachyphyllum* like its geographical range is very great. The earliest recorded occurrence is that of a very doubtful species described by Feistmantel<sup>2</sup> from the Permo-Carboniferous of New South Wales (Newcastle beds). The genus reappears in the upper Triassic becoming prominent during the Jurassic and Lower Cretaceous and dies out during the first half of the Upper Cretaceous.

Recently discovered structural material has enabled Hollick and Jeffrey<sup>3</sup> to settle in a measure the botanical affinity of at least one species, *Brachyphyllum macrocarpum*. The leaves are shown to be attached by practically the whole ventral surface, only the margins being free and these sometimes overlap. They refer this species to the subfamily Araucariæ on the evidence of the branched leaf trace, the mucilaginous contents of the resin canals, the Araucarioxylon type of flattened and alternating bordered pits, the lateral pits of the ray cells and the absence in the phloem of regularly alternating rows of hard bast fibers.

*Brachyphyllum* is not a prominent type in the Potomac flora although it is by no means as rare as it was thought to be some years ago. *Brachyphyllum parceramosum*, the Patuxent species, has been met with rather infrequently, but *Brachyphyllum crassicaule* is not uncommon at a relatively large number of Patapsco outcrops.

#### BRACHYPHYLLUM CRASSICAULE Fontaine.

*Brachyphyllum crassicaule* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 221, pl. 100, fig. 4; pl. 109, figs. 1-7; pl. 110, figs. 1-3; pl. 111, figs. 6, 7; pl. 112, figs. 6-8; pl. 168, fig. 9.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 529, 557, pl. 113, fig. 6.

*Description.*—In 1890 Fontaine described this species as follows:

Trees with large branches, irregularly pinnate; on the penultimate twigs the ultimate branches lower and next to the main branch subdivide pinnately into branches; those higher are unbranched and simple; ultimate branches vary in numbers and closeness, sometimes few and remote, and again crowded, contiguous, almost touching toward the summit of the penultimate branches the ultimate ones become much crowded and grow gradually shorter, are cylindrical, and taper grad-

<sup>1</sup> Velenovsky, Gym böhm. Kreidef., 1885, p. 16, pl. 6, figs. 3, 6-8; Květena českého cenomanu, 1889, p. 9, pl. 1, figs. 11-19; pl. 2, figs. 1, 2.

<sup>2</sup> Feistmantel, Palaeont., Suppl. 3, 1878, p. 97, pl. 7, figs. 3-6; pl. 17.

<sup>3</sup> Hollick and Jeffrey, Amer. Nat., vol. 40, 1906, p. 200.

ually to an obtuse point; leaf-scars of young leaves elliptical in shape, slightly prolonged in the direction of the axes of the stems, and such leaves seem to have been fleshy, slightly convex, and with a free tip slightly keeled in the upper half; with age the leaves become broader and more convex, being broadly elliptical, almost circular, and they leave similar scars after their fall; when crowded and dilated with age the leaves and leaf-scars are subrhombic or rhombic in shape; the surface of the leaves, which is very rarely preserved, shows fine tubercles or dots, arranged in curving lines parallel to their margins and converging toward their tips; cones small, globular, or subelliptical in shape, attached laterally to the penultimate twigs, taking the place of ultimate branches; scales numerous, spirally arranged, touching, shape not made out, but probably with age rhombic and polygonal.

This species is fairly common in Virginia in beds of both Patuxent and Patapsco age, while in Maryland it occurs exclusively, as far as known, in deposits referred to the Patapsco formation.

*Brachyphyllum crassicaule* is very similar to the European *Brachyphyllum obesum* Heer<sup>1</sup> with which Seward<sup>2</sup> unites it tentatively. This latter species is found in the English Wealden and in the Urganian and Aptian of Portugal. While these European and American forms are very similar, it should be remembered that this similarity runs through all the members of this genus, and these two species are so widely removed geographically it has seemed best to maintain their distinctness. *Brachyphyllum obsiforme* Saporta<sup>3</sup> from beds of Albian age in Portugal is also very similar to the forms under discussion. Finally the Patapsco species is very similar to the single Upper Cretaceous species of America, *Brachyphyllum macrocarpum* Newberry, and is undoubtedly its ancestral form.

*Occurrence.*—PATUXENT FORMATION: Trents Reach and Dutch Gap, Virginia; PATAPSCO FORMATION: Near Brooke, near Widewater, Dumfries Landing, Virginia; Fort Foote, Federal Hill (Baltimore), near Glymont, Stump Neck, Maryland.

*Collections.*—U. S. National Museum, Johns Hopkins University, Maryland Academy of Sciences, Goucher College of Baltimore.

#### BRACHYPHYLLUM PARCERAMOSUM Fontaine.

*Brachyphyllum parceramosum* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 223, pl. 110, fig. 4.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 517, 538.

*Brachyphyllum texense* FONTAINE, Proc. U. S. Nat. Mus., vol. 16, 1893, p. 269, pl. 38, figs. 3-5; pl. 39, figs. 1, 1a.

*Description.*—Fontaine's original description was as follows:

Twigs branching sparingly and dichotomously; leaves and leaf-scars elliptical to subrhombic, with the longer dimensions in the direction of the length of the twigs; leaves convex, spirally arranged, showing a keel in their upper portions, closely appressed, contiguous, prolonged very slightly at the tips, branches cylindrical, of the same thickness throughout; so far as can be seen about 4 mm. in diameter.

<sup>1</sup> Heer, Contr. Flora Foss. Port., 1881, p. 20, pl. 17, figs. 1-4.

<sup>2</sup> Seward, Wealden Flora, pt. 2, 1895, p. 218, pl. 17, fig. 9; pl. 20, figs. 1.

<sup>3</sup> Saporta, Flora foss. Port., 1894, p. 176, pl. 31, figs. 12, 13; pl. 33, fig. 4; pl. 34, fig. 8.



This form, which is of rare occurrence, is possibly not specifically distinct from *Brachyphyllum crassicaule* Fontaine, which in turn is very closely allied to various European forms. It may be distinguished, however, from the preceding species by its slender branches, which rarely fork, and then in an apparently dichotomous manner (this is only apparent, however, and not real dichotomy), and by its more regular, pointed, slightly keeled leaves. The specimens from Glen Rose, Texas, described as new by Professor Fontaine, are not distinguishable from the Maryland and Virginia specimens of *Brachyphyllum parceramosum*.

*Brachyphyllum parceramosum* is retained as a distinct species because of the inconclusive nature of the material and because it occurs in beds of somewhat greater age than *Brachyphyllum crassicaule* and because in habit it more nearly resembles the less branched Jurassic types rather than the more regularly and pinnately branched Cretaceous types, the latter type culminating in *Brachyphyllum macrocarpum* of the Upper Cretaceous. The great similarity among all of the species in this genus when studied as poorly preserved impressions tends to enforce caution on the student who would unite under one name forms which appear to be similar, but which are widely removed either geologically or geographically. The European representative of *Brachyphyllum parceramosum* is *Brachyphyllum obesiforme elongatum* Saporta, which occurs in the Albian of Portugal.

*Occurrence*.—PATUXENT FORMATION: Telegraph Station (Lorton), Virginia; New Reservoir, District of Columbia. ARUNDEL FORMATION: Arlington, Maryland.

*Collections*.—U. S. National Museum.

#### THE GENUS SEQUOIA.

The genus *Sequoia* was proposed by Endlicher in 1847,<sup>1</sup> being based upon the still existing species of the Pacific coast of North America. What appears to be the earliest authentic record of a fossil *Sequoia* is furnished by the cones collected in the Portlandian of France.<sup>2</sup>

Ranging through the succeeding Lower Cretaceous deposits about a dozen species are known. The localities include Maryland, Virginia, California, Montana, Wyoming, and Texas, and outside the United States British Columbia, Greenland, Mexico, Spitzbergen, Portugal, Belgium, Germany, Switzerland, England, and Russia. Wood of the *Sequoia* type of structure is also known from the Lower Cretaceous of this country and Europe. In the Upper Cretaceous species of *Sequoia* become still more abundant and they apparently extend their range and specific differentiation throughout the greater portion of the succeeding Tertiary period, some of the forms, repre-

<sup>1</sup> Endlicher, *Synop. Conif.*, 1847, p. 197.

<sup>2</sup> Fliche and Zeiller, *Bull. soc. géol. France* (4), vol. 4, 1904, p. 798, pl. 19, figs. 4, 5.



sented by foliage, cones, and wood, being almost identical with the modern redwood *Sequoia sempervirens* (Lambert) Endlicher, while others appear to be ancestral to the modern big tree of California *Sequoia washingtoniana* (Winslow) Sudworth. The climatic changes of the Pleistocene seem to have inaugurated the extinction of this type which had previously become restricted in America by the extensive development of the plains type of country, which was too arid for their continued existence. Both the *sempervirens* and the *washingtoniana* type are present in the Pliocene of Europe at a large number of localities, as well as three or four additional species represented by twigs, cones, seeds, and wood.

In the present flora the redwood is common in the Coast Range from Oregon southward to Monterey County, California, while the "big tree" is confined to the west slopes of the Sierras from southern Placer County to Tulare County, California.

SEQUOIA REICHENBACHI (Geinitz) Heer.<sup>1</sup>

*Araucarites reichenbachi* GEINITZ, Charak. Schichten u. Petref. sach-bohm Kreide, pt. 3, 1842, p. 98, pl. 24, fig. 4.

*Araucaria reichenbachi* DEBEY, Ent. Geogn. Darst. Gegend von Aachen (Nachtrage, 1849.

*Sequoia reichenbachi* HEER, Flora Foss. Arct., vol. 1, 1868, p. 83, pl. 43, figs. 1d, 2b, 5a.—FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 243, pl. 118, figs. 1, 4; pl. 119, figs. 1-5; pl. 120, figs. 7, 8; pl. 122, fig. 2; pl. 167, fig. 5.—NATHORST, in Felix and Lenk, Beitr. Geol. u. Pal. Mexico, 1893, p. 52, figs. 4, 5.—FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., Pt. 2, 1899, p. 674, pl. 165, figs. 1, 2; pl. 166, fig. 1.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 177, 263, 281, 544, pl. 55, figs. 7, 8; pl. 69, figs. 4, 5.

*Sequoia reichenbachi longifolia* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 244, pl. 117, fig. 8.

*Sequoia densifolia* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 246, pl. 121, fig. 4.

*Sequoia* (?), species FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 248, pl. 116, fig. 7; pl. 132, figs. 2, 5, 6.

*Sequoia*, species FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 248, pl. 132, fig. 10.

*Sequoia* (?) *inferna* WARD, Fontaine, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 507.

*Sequoia couttsix* (not Heer) HOLLICK, Trans. N. Y. Acad. Sci., vol. 12, 1892, p. 30, pl. 1, fig. 5.

*Description.*—This is one of the most wide-ranging fossil plants, both geologically and geographically, that is known, and it seems very probable that it is of a composite character, the well-known difficulty of distinguishing between coniferous twigs of this character prohibiting any satisfactory segregation. Described originally as a species of *Araucarites*, certain of these remains from the Staten Island Cretaceous have shown by their vascular structure that they are allied to the *Araucariæ*, while, on the other hand, a large number of

<sup>1</sup> Only such citations as have some bearing on the Potomac occurrence of this species are mentioned in the synonymy.

exactly similar remains of leaf-bearing twigs bore cones which are unquestionably those of a *Sequoia*. Twigs of this sort are abundant throughout the Potomac group, occurring also in the Fuson formation of the Black Hills, the Kootanie of Montana, the Shasta of California, the Kome beds of Greenland, and the Neocomian of central Mexico. Abroad they have been reported from the Upper Jurassic (?) of Portugal, the Neocomian of Belgium, the Urganian of Silesia, and the Gault of Switzerland. Similar remains have also been described from a large number of horizons in the Upper Cretaceous, both in this country and abroad.

The slight variations from specimen to specimen and the varying conditions of preservation in the twigs of this species throughout the Potomac deposits, together with the detached and more or less macerated cones, furnished the basis for six species and varieties of Fontaine and Ward, but these are obviously not specifically distinct from one another.

*Occurrence*.—PATUXENT FORMATION: Fredericksburg, Lorton (Telegraph Station), and Dutch Gap, Virginia; Springfield, Maryland. ARUNDEL FORMATION: Reynolds Ore Pit, Maryland. PATAPSCO FORMATION: Near Brooke, Virginia.

*Collections*.—U. S. National Museum.

#### SEQUOIA RIGIDA Heer.

*Sequoia rigida* HEER, Flora Foss. Aret., vol. 3, pt. 2, 1873, pp. 80, 91, 102, 128, pl. 22, figs. 5g, 11a; pl. 25, fig. 6; pl. 27, figs. 8-14; pl. 38, figs. 9a, 10.—SCHENK, Palaeontographica, vol. 23, 1875, p. 168, pl. 29, figs. 8, 9.—HEER, Flora Foss. Aret., vol. 6, pt. 2, 1882, p. 52, pl. 7, figs. 10-12; pl. 8, fig. 7; pl. 11, fig. 1c; pl. 24, fig. 3b; vol. 7, 1883, p. 13, pl. 53, figs. 5-7.—FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 246, pl. 118, fig. 3; pl. 121, fig. 2; pl. 126, fig. 3; pl. 130, fig. 3.—KNOWLTON, in Stanton and Martin, Bull. Geol. Soc. Amer., vol. 16, 1905, p. 408.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 219.

*Sequoia subulata* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, 245, pl. 117, fig. 7; pl. 118, figs. 5, 6 (not Heer).—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 486, 571 (not Heer).

*Description*.—This species was described by Heer from the Kome beds of Greenland, although he subsequently pointed out that it was more abundant in the Atane beds. He compares it with *Sequoia woodwardii* (Carruthers) Schimper of the upper Greensand of England and with *Sequoia pectinata* Heer of the Senonian of Germany. It is also recorded from the Gosau beds of Europe and from the Upper Cretaceous of Alaska as well as from the Potomac of Virginia, the Kootanie of Montana, and the Shasta of California. The specific identity of these Upper and Lower Cretaceous forms may well be doubted, but no clear line of demarcation can be drawn between them at the present time. It is quite possible that the Potomac forms are merely variants of the abundant *Sequoia reichenbachii*, since they fail to show the transverse rugosity (a feature of the preservation merely)

described by Heer. They also appear to be somewhat less decurrent and less finely pointed than the type material. A variety described by Saporta from the Albian of Portugal as var. *lusitanica*<sup>1</sup> is scarcely to be distinguished from the Potomac specimens.

*Occurrence.*—PATUXENT FORMATION: Near Potomac Run, near Telegraph Station (Lorton), Virginia; Springfield, Maryland.

*Collections.*—U. S. National Museum.

#### SEQUOIA DELICATULA Fontaine.

*Sequoia delicatula* FONTAINE, Monogr. U. S. Geol. Survey, vol. 15, 1890, p. 247, pl. 121, fig. 3.

*Description.*—In 1890 Fontaine furnished the following description of this species:

Principal twigs slender, penultimate and ultimate ones all in one plane, minute, short, closely placed, alternate and pinnate in arrangement; leaves very small, narrowly linear, acute or acuminate, widest at base, decurrent, and mostly crowded; midnerve slender but distinct.

Professor Fontaine says of this species:

This plant is a good deal like *Sequoia subulata*, but the leaves are proportionally wider and not so falcate, while the ultimate branches are placed at more uniform intervals.

It may be doubted whether it is really distinct from the abundant *Sequoia reichenbachii*, since it was extremely rare at the single Virginia locality from which it was originally collected and it has not been met with in any of the subsequent collections. It is not especially well marked and is of little significance, although it has seemed best to keep it distinct at the present time.

*Occurrence.*—PATUXENT FORMATION: Near Dutch Gap, Virginia.

*Collections.*—U. S. National Museum.

#### SEQUOIA AMBIGUA Heer.

*Sequoia ambigua* HEER, Flora Foss. Arct., vol. 3, pt. 2, 1874, pp. 78, 91, pl. 21, figs. 1-11; pl. 25, fig. 5; vol. 6, pt. 2, 1882, pp. 17, 52, pl. 1, fig. 3.—FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 245, pl. 118, fig. 2; pl. 120, figs. 1-6; pl. 127, fig. 5; pl. 132, fig. 3.—NATHORST, in Felix and Lenk, Beitr. Geol. and Pal. Mexico, 1893, p. 51, figs. 1-3.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 272, 281, 538, 555, pl. 69, fig. 6; pl. 110, fig. 13.

*Sphenolepidium recurvifolium* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 258, pl. 127, fig. 2; pl. 130, figs. 2, 7.

*Sphenolepidium dentifolium* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 258, pl. 128, figs. 2-6; pl. 129, fig. 5; pl. 130, figs. 4-6, 10.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 484, 528, 538, 546, 555.

*Sequoia gracilis* FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., pt. 2, 1899, p. 675, pl. 166, fig. 2 (not Heer).

*Arthrotaxopsis expansa* FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 533, 535, 538, 555, 573, pl. 109, figs. 12, 13 (not pp. 504, 520, 546, 547, 571),

<sup>1</sup> Saporta, Flora foss. Portugal, 1894, p. 177, pl. 33, figs. 7-12.

*Description.*—Remains of the foliage of this species are distinguishable from those of contemporaneous conifers which occur in the beds with them by the relatively short and very stout, acuminate, falcate, or recurved, decurrent leaves.

The cones are spherical and consist of relatively few short scales with longitudinally striated peduncles and suddenly expanded, quadrangular, peltate, umbilicate tips. These cones are abundant in the lower Cretaceous of Maryland, occurring usually as detached ferruginized mud casts. They vary considerably in size, and this has resulted in their having been referred to two species and genera, the smaller having been identified by Professor Fontaine as *Arthrotaxopsis expansa*, while the larger were referred to *Sequoia ambigua*. As Professor Ward pointed out in his monograph,<sup>1</sup> they show no differences except in size, and even this feature has rather narrow limits of variation with every gradation present. The writer has carefully compared a large suite of specimens and many wax casts of the scales and finds them absolutely identical in every respect, the relative proportions of the scales from the smallest and the largest cones giving the same ratios of length, width, and height.

As recorded in the literature cited above, *Sequoia ambigua* is widely distributed geographically and it has an equally great geological range. Described originally from the Kome beds (Urgonian) of Greenland by Professor Heer, this author soon afterwards recorded it from the Upper Cretaceous Atane beds of that country. It has been recorded by Nathorst from the Neocomian of Mexico and it is present in the Kootanie formation of Montana. It is a member of the Shasta flora of the Pacific coast (Horseshoe beds) and is probably represented in the Fuson formation of eastern Wyoming by what Professor Fontaine calls *Sequoia gracilis*. In the Upper Cretaceous, remains in every way identical with these Lower Cretaceous occurrences are present in the Magothy formation at Gay Head and at a number of localities in Maryland as well as in the Tuscaloosa formation of Alabama.

In the Potomac group this species ranges from the base of the Patuxent, through the Arundel to the top of the Patapsco often in considerable abundance. Seward<sup>2</sup> comments on the resemblance between *Sequoia ambigua* Heer and the widespread remains of *Sphenolepis sternbergiana* (Dunker) Schenk, a resemblance strikingly shown in some Wealden specimens of the latter from Ecclesbourne recently received by the writer. However, their preservation is not of the best, and the English specimens seem to show slight differences from the type of this species in the direction of what in America is identified as *Sequoia ambigua*. No changes in nomenclature are proposed, however, since it seems probable that *Sphenolepis sternberg-*

<sup>1</sup> Monogr. U. S. Geol. Surv., vol. 48, 1906.

<sup>2</sup> Wealden Flora, pt. 2, 1895, p. 206.



*iana* in North America is properly identified and distinct from *Sequoia ambigua*, which is more open and stouter and which may be present in the English Wealden in some at least of the coniferous twigs identified as *Sphenolepis sternbergiana*.

*Occurrence.*—PATUXENT FORMATION: Fredericksburg, Dutch Gap, Cockpit Point, Potomac Run, Telegraph Station, Virginia; ARUNDEL FORMATION: Soper Hall, Riverdale, Arlington, Muirkirk, Schoolhouse Hill (Hanover), Maryland; PATAPSCO FORMATION: Federal Hill (Baltimore), Locust (Poplar) Point, Fort Foote, Maryland.

*Collections.*—U. S. National Museum, Johns Hopkins University.

#### THE GENUS ABIETITES.

Since its establishment by Hisinger<sup>1</sup> in 1837 this genus has been a convenient and perhaps useful repository for fossils whose real or fancied affinities were thought to suggest the modern genus *Abies*. They have ranged in age from the Keuper to the Pliocene, the bulk coming from the Cretaceous, and consisting of obscure impressions of foliage and cones, none of which have any real biological value or present any definite clue to their true relationship. Professor Fontaine has included in this genus fossils from the Triassic of North Carolina and various indefinite remains from the Trinity group of Texas, the Shasta group of California, the Lakota formation of the Black Hills, and the Potomac group of Maryland and Virginia. The latter he segregates into four species, all of which are based upon obscure cone impressions and none of which possess much specific value. When it is remembered what diverse appearances may be assumed by a single species of cone irrespective of individual variation and due merely to different stages of maceration before preservation, to differences in the matrix, and to differences in the direction and force of compression, it seems very probable that we are dealing with a single species of cone, or at least not more than two, instead of the four which are in the literature relating to the Potomac.

Similar forms from the English Wealden are described by Caruthers, Gardner, and Seward, and referred to the comprehensive genus *Pinites* of Endlicher (1847). They are in all probability congeneric if not specifically identical with *Abietites macrocarpus* Fontaine, whose generic and specific name is here retained in order to avoid unnecessary changes and because Endlicher's *Pinites* is antedated by *Pinites* Witham (1833), something altogether different. In the French Neocomian also, cones of this character are abundant, Cornuel<sup>2</sup> describing five species and referring them to *Pinus*. His *Pinus submarginata* is especially suggestive of *Abietites macrocarpus*

<sup>1</sup> Hisinger, *Lethæa suecica*, 1837, p. 110.

<sup>2</sup> Cornuel, *Bull. soc. géol. France* (II), vol. 23, 1866, pp. 658-673, pl. 12.



Fontaine, as are also some of the species described by Coemans<sup>1</sup> from the Lower Cretaceous of Belgium and by Carruthers<sup>2</sup> from the Gault of England. Finally the foliage from the Potomac beds which has been referred to *Leptostrobus* and *Laricopsis* is neither *Leptostrobus* nor related to the modern *Larix*, and since such foliage in the English Wealden is in organic union with cones of the *Abietites macrocarpus* type,<sup>3</sup> it seems eminently proper in the treatment of the American material to associate this type of foliage with the corresponding type of cone.

ABIETITES MACROCARPUS Fontaine.

*Abietites macrocarpus* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 262, pl. 132, fig. 7.—FONTAINE, in Ward., Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 261, 547, pl. 68, figs. 15, 16; pl. 115, figs. 2, 3.

*Abietites ellipticus* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 263, pl. 132, figs. 8, 9; pl. 133, figs. 2-4; pl. 168, fig. 8.

*Abietites angusticarpus* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 263, pl. 133, fig. 1.—FONTAINE, 19th Ann. Rept. U. S. Geol. Surv., Pt. 2, 1899, p. 671, pl. 163, fig. 14.—FONTAINE, in Ward., Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 528, 538, 556, 572, pl. 114, fig. 10.

*Williamsonia? bibbinsi* WARD, Fontaine, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 554, pl. 115, fig. 11.

*Abietites californicus* FONTAINE, in Diller and Stanton, Bull. Geol. Soc. Amer., vol. 5, 1894, p. 450 (*nomen nudum*).

*Description.*—Large, stout cones, with a stout axis and numerous, long, thin, imbricated, appressed scales. The various specimens vary considerably in length and appearance, all being much macerated and poorly preserved.

The author is unable to find good characters for the separation of the forms included in the foregoing synonymy. The supposed *Williamsonia* is nothing but a cone fragment vertically compressed as Professor Ward surmised. Described originally from the Patuxent formation of Virginia they have since been identified in the Shasta group (Horsetown beds) of California and the Lakota formation of the Black Hills, while a very similar cone fragment has been described from the Trinity group of Texas as *Abietites linkii* (Roemer) Dunker.

These cones are comparable with a number of previously described species, and they are especially close to *Pinites solmsi* Seward from the English Wealden, as the latter author has already pointed out. From the foliage preserved with the English cones, which is identical with what Professor Fontaine referred to *Leptostrobus*, it is possible that the latter type of foliage was borne by the tree which furnished the cones just described.

<sup>1</sup> Coemans, Mém. Acad. Roy. Belg., vol. 36, 1867.

<sup>2</sup> Carruthers, Geol. Mag., vol. 3, 1866, pp. 534-546, pl. 20, 21.

<sup>3</sup> Seward, Wealden Flora, pt. 2, 1895, p. 197, pl. 18, figs. 2, 3; pl. 19. See especially pl. 18, fig. 2.

*Occurrence.*—PATUXENT FORMATION: Fredericksburg, Dutch Gap, Virginia, Broad Creek, Maryland; ARUNDEL FORMATION: Arlington, near Lansdowne, Maryland; PATAPSCO FORMATION, Vinegar Hill, Fort Foote, Maryland.

*Collections.*—U. S. National Museum.

ABIETITES MARYLANDICUS Fontaine.

*Abietes marylandicus* FONTAINE, in Ward., Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 549, pl. 115, figs. 4, 5.

*Description.*—Obscure impression of a narrowly oblong cone about 15 mm. wide and about 4 cm. long, covered with closely placed, rhomboidal sears, transversely elongated. The very stout peduncle might be taken to indicate a stout cone with thin scales of which only the basal portions were retained in the fossil. The relation of this cone to the preceding species is altogether doubtful, it is retained in this genus since the preservation is so vague that any effort to determine its true affinity would be futile.

In some respects it suggests the staminate cone of a eyead and it may also be compared with cones of the coniferous genus *Geinitzia* which are characteristic forms in the Albian, Cenomanian, and Senonian.

*Occurrence.*—PATAPSCO FORMATION: Vinegar Hill, Maryland.

*Collection.*—U. S. National Museum.

ABIETITES FOLIOSUS (Fontaine).

*Leptostrobus foliosus* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 230, pl. 101, fig. 4; pl. 103, fig. 5; pl. 104, fig. 1; in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 482.

*Laricopsis longifolia* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 233, pl. 102, figs. 7, 8; pl. 103, figs. 2, 3; pl. 165, fig. 4; pl. 168, figs. 5, 6.—FONTAINE, Proc. U. S. Nat. Mus., vol. 16, 1893, p. 268, pl. 36, fig. 9 (?).—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 312, pl. 73, figs. 11, 14.

*Description.*—Leaves long and slender, 0.5 to 1.0 mm. in width, full length not seen, at least several centimeters, much crowded, seemingly in bundles where the preservation is fairly good.

This is clearly distinct from the preceding species and less common. It is not fully characterized because of the poorness of preservation, as evinced by the fact that the leaves are detached in a majority of the specimens collected. The forms which were the basis for *Laricopsis longifolia* Fontaine have been united with this species since they are indistinguishable and probably identical in character.

This species occurs at the oldest and youngest horizons in the Virginia Potomac and it has also been recorded from the Kootanie formation of Montana. The fragment from the Trinity beds of Texas which Professor Fontaine identifies with such certainty is, in the writer's judgment, absolutely untrustworthy.

*Occurrence.*—PATUXENT FORMATION: Dutch Gap and immediate vicinity, Virginia; PATAPSCO FORMATION: Brooke, Virginia.

*Collections.*—U. S. National Museum.

**ABIETITES LONGIFOLIUS (Fontaine) New Combination.**

*Leptostrobus longifolius* FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 228, pl. 101, figs. 2, 3; pl. 102, figs. 1-4; pl. 103, figs. 6-12; pl. 104, fig. 6.—FONTAINE, in Ward, 19th Ann. Rept. U. S. Geol. Surv., Pt. 2, 1899, p. 671, pl. 163, fig. 15; pl. 165, fig. 3.—FONTAINE, in Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, pp. 281, 481, 482, 491, 506, 528, 551, 557, pl. 110, fig. 11; pl. 116, fig. 1.

*Description.*—Leaves long and narrow, needlelike, 10 to 15 cm. in length, aggregated in bundles. Bundles apparently borne on short shoots, with many leaves in each bundle. No satisfactory venation can be made out. Fontaine describes a various number of veins in these forms, but as nearly as can be determined these are simply folds due to compression or simply the angles of the leaf.

This species has a considerable geologic as well as geographic range, having been recorded from the Kootanic formation of British Columbia and the Fuson formation of the Black Hills. In the Potomac group it is of frequent occurrence and individually common, being found in the oldest as well as the youngest beds. The remains are always poorly preserved and were evidently much macerated before fossilization. They are closely comparable with *Pinites solmsi* Seward of the Wealden and with *Pinus peterseni* Heer from the Kome beds of Greenland. They may also be compared with the genus *Prepinus* proposed by Professor Jeffrey for certain structural material from the Upper Cretaceous.

The genus *Leptostrobus* was proposed by Heer<sup>1</sup> in 1876 for certain Siberian Jurassic cones, although in 1880 remains of foliage were also correlated with these cones.<sup>2</sup> Five species in all were described. The age of the containing beds is Oolitic. Subsequently this generic name was utilized by Ward and Fontaine for a considerable number of American Jurassic and Cretaceous species, based on an assortment of probably unrelated vegetative twigs, supposed cones, and seeds or fruits.

*Occurrence.*—PATUXENT FORMATION: Fredericksburg, Potomac Run, and Dutch Gap, Virginia; PATAPSCO FORMATION: Brooke, 72-mile post, Mount Vernon and Hell Hole, Virginia; Fort Foote, Vinegar Hill (very common), and Federal Hill (Baltimore), Maryland.

*Collection.*—U. S. National Museum.

THE GENUS PINUS.

Modern members of this genus are the dominant conifers of the northern hemisphere with about 70 species, usually forming vast forest

<sup>1</sup> Heer, *Flora Foss. Arct.*, vol. 4, Abth. 2, 1876, p. 72.

<sup>2</sup> Heer, *Idem.*, vol. 6, Abth. 1, 1880, p. 23

areas. There are considerable differences of opinion at the present time among morphologists as to the relative antiquity of the various members of the order Coniferales, the older view that the Abietineæ were a highly specialized and relatively modern type being questioned by Jeffrey and others. It would seem, however, that the old view not only has the fossil record exclusively in its favor but many morphological arguments to substantiate it.

A very large number, perhaps as many as 200, of fossil species have been described, ranging in age from the Jurassic upward. The Jurassic has furnished pine-like leaves as well as the remains of cones which have formed the foundation of several species. While these records are for the most part not entirely unequivocal, Fliche and Zeiller<sup>1</sup> in a recent communication are positive of the identity of the cone which they describe from the French Portlandian. From horizons homotaxial with the Potomac group, a number of forms have been recorded. These include six species described by Heer from leaves in the Kome beds, three species from the Kootanic, one from the Lakota of the Black Hills, and one from the Trinity of Texas. Strata of Lower Cretaceous age in Europe are remarkable for the number, variety, and excellent preservation of cones of *Pinus*, about a dozen species being known from England, Belgium, and France. The Upper Cretaceous records are frequent and conclusive, including the evidence of wood with structure preserved, and the genus becomes thoroughly cosmopolitan during the Tertiary period. The definite remains of *Pinus* in the Potomac group are those of both cones and seeds constituting the following single species, the cones of which sometimes crowd the strata of the Patapsco formation.

**PINUS VERNONENSIS** Ward emend.

*Pinus vernonensis* WARD, in Fontaine, in Ward., Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 497, pl. 109, figs. 4-6.

*Pinus schista* WARD, Monogr. U. S. Geol. Surv., vol. 48, 1905, p. 531, pl. 112, figs. 13-15.

*Araucarites virginicus* FONTAINE, in Ward., Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 572, pl. 119, fig. 8 (not Fontaine, 1890).

*Seed of Pinus?*, species FONTAINE, Monogr. U. S. Geol. Surv., vol. 15, 1890, p. 272, pl. 170, fig. 4.

*Description.*—Cones elongate, conical, somewhat variable in size, averaging about 7 cm. in length by 1.8 cm. in diameter. Axis stout, 2 mm. to 3 mm. in diameter. Cone scales triangular, relatively thin, thickened apically to form a rhomboidal boss with an elevated transverse ridge. A central umbilicus may represent the area of attachment of a short spine which has been worn away before fossilization. Length about 1.5 cm., greatest width about 0.8 to 1 cm., thickness 1 to 2 mm.

<sup>1</sup> Fliche and Zeiller, Bull. Soc. geol. France (4), vol. 4, 1904, p. 804.



The arrangement of the scales is a close spiral, and in all of the cones collected or seen, numbering several score, none were found expanded, all having the scales closely appressed. This may indicate fossilization before maturity, since also numbers of the cones retain their seeds, which is remarkable if the cones were shed in a ripe state. The seeds seem to be mature, however, and it is probable that the cones in this species had reached nearly or quite their full size when they were blown into some Lower Cretaceous stream and carried out and buried in the Patapsco estuaries. Each cone scale subtends two seeds which are typically those of *Pinus*. The seeds are elliptical, 3–5 mm. long with straight wings 5–15 mm. high and not over 7 mm. wide, sides rather straight though somewhat curved on the outside, obtusely rounded apically.

The single seed from Federal Hill represents the maximum of size as given above and is also rather more pointed than the specimens from the other localities. It was doubtfully described by Fontaine in his first monograph. More recently Professor Ward discovered seeds of *Pinus* at Mount Vernon, Virginia, and at Fort Foote, Maryland. The former were described as *Pinus vernonensis*, which now becomes the name of all the *Pinus* like remains from the Patapsco formation. The latter specimens were described as a distinct species, *Pinus schista*, because the wings are somewhat split. As the latter are identical with the more complete remains from the other bank of the Potomac, and as the different specimens are split to a varying degree and one specimen is not split at all, it is quite obvious that the splitting is due entirely to trituration before fossilization.

Recently the writer discovered abundant lignitized cones associated with these seeds near Widewater, Virginia, and these cones were found in a number of instances to still contain some of their seeds which proved to be identical in every respect with the seeds previously described from the Patapsco formation. Having become familiar with the cones which bore the pine seeds it was found that the single cone described by Fontaine<sup>1</sup> from Cecil County, Maryland, as identical with *Araucarites virginicus* was in reality a pine cone identical in every respect with the cones from near Widewater, Virginia.

The seeds of *Pinus vernonensis* may be compared with those figured by Seward<sup>2</sup> from the Wealden of Bernissart, Belgium as *Pinites* cf. *Solmsi*. In the U. S. National Museum collections a number of specimens of *Widdringtonites brookense* are labeled *Pinus vernonensis* in Professor Fontaine's handwriting, but there is no record in print of supposed foliage of this species, although it is possible that some of the foliage specimens referred to *Abietites* in the present paper may have had such a relationship.

<sup>1</sup>In Ward, Monogr. U. S. Geol. Surv., vol. 48, 1906, p. 572, pl. 119, fig. 8.

<sup>2</sup>Seward, La Flora Wealden de Bernissart, Mém. Musée roy. d'hist. nat. de Belgique, Année 1900, p. 28, pl. 4 fig. 77.

*Occurrence.*—PATAPSCO FORMATION: Mount Vernon (seeds) and near Widewater, Virginia (cones and seeds): Federal Hill (Baltimore) (seed) and Fort Foote (seeds); Muddy Creek, Cecil County (conc), near Wellhams, Anne Arundel County (seeds), Maryland.

*Collections.*—U. S. National Museum, Johns Hopkins University.